

MINIATURE HIGH INTENSITY LED ILLUMINATION SOURCE

Statement of Government Interest

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Background of the Invention

This invention relates to devices for curing adhesives to bond objects together. In particular, this invention relates to a device adapted for radiating light onto photo-curable adhesives in different ambient conditions.

Adhesive compounds have been developed that initiate curing when they are radiated by light from an electric lamp. The curing light may be not only visible light, but also other wavelengths, such as ultraviolet or infrared. Typically, two part reactive adhesives (epoxies, etc) are temperature dependent and cure sluggishly or not at all in the cold temperatures found in seawater. These cold water conditions also are extreme for divers, and little time can be afforded to wait on adhesive to cure in a remote application. Divers do not have an acceptable quick bonding adhesive system in demanding underwater applications where speed of curing is effective throughout the range of seawater conditions (90°F-29.5°F).

Thus, in accordance with this inventive concept, a need has been recognized in the state of the art for a user friendly

1 bonding system that can be transported, operated, and applied to  
2 cure bonding adhesive quickly in extreme conditions.

3 Summary of the Invention

4 An object of the invention is to provide a compact, user-  
5 friendly system to cure photo-curable adhesives with light.

6 Another object of the invention is to provide a user-  
7 friendly system to bond objects underwater or in air under  
8 adverse conditions.

9 Another object of the invention is to provide a portable,  
10 miniature system utilizing a high powered illumination source for  
11 curing photo-curable adhesives underwater and in-air.

12 Another object of the invention is to provide a safe, user-  
13 friendly system to cure adhesives and operable underwater by  
14 heavily gloved hands.

15 Another object of the invention is to provide a portable,  
16 miniature system utilizing a high powered LED illumination source  
17 for curing photo-curable adhesives underwater and in-air and  
18 additionally can be used as a high intensity LED lamp.

19 Another object of the invention is to provide a user-  
20 friendly device transported to and operated at a work site to  
21 cure a bonding adhesive quickly in extreme conditions.

22 These and other objects of the invention will become more  
23 readily apparent from the ensuing specification when taken in  
24 conjunction with the appended claims.

25 Accordingly, the invention provides an apparatus for curing  
26 an adhesive with high-intensity radiation. A housing has an

1 insulating cylindrical section and disc-shaped section to define  
2 an interior. An LED array in the housing is separated from  
3 batteries by an insulating layer. A switching mechanism mounted  
4 on the outside of the housing is displaced to close contacts of a  
5 switch relay in the housing to connect power from the batteries  
6 to the LED array. The LED array emits the high-intensity  
7 radiation through a transparent cover to cure an adhesive.

8 Brief Description of the Drawings

9 FIG. 1 is a top view of the illumination source of the  
10 invention.

11 FIG. 2 is a cross-sectional side view of the illumination  
12 source of this invention taken generally along line 2-2 in FIG. 1  
13 and showing bonding of a photo-curable adhesive after being  
14 transported to and placed on a submerged surface.

15 Description of the Preferred Embodiments

16 Referring to FIGS. 1 and 2 of the drawings, illumination  
17 source 10 provides a miniature, high-powered source of energy for  
18 curing photo-curable adhesives in different underwater and in-air  
19 applications, such as in ambient water 11. Illumination source  
20 10 is intended to include those sources of radiation that may be  
21 used to cure adhesives including photo-activated adhesives.  
22 Illumination source 10 is compact enough to be easily transported  
23 to work-site 6 by a workman, and is ergonomically designed for  
24 use by an operator wearing heavy gloves. It reliably operates  
25 over temperature ranges between 90°F-29.5°F underwater and over

1 ambient temperatures in air or other places where curing of  
2 adhesives is needed to bond surfaces and/or objects together.

3 FIG. 2 depicts illumination source 10 adjacent work site 6  
4 that has an envelope of photo-curable adhesive 7 between a  
5 radiation transparent structural member 8 and submerged slab 9.  
6 Member 8 is being bonded to submerged slab 9 as high intensity  
7 radiation 10a from source 10 is being emitted. The properties of  
8 adhesive 7 are such as to be cured by the emitted high-intensity  
9 radiation 10a in not only this exemplary arrangement of adhesive  
10 7, member 8 and surface 9, but other arrangements as well. This  
11 is due to the high levels of radiation 10a emitted by source 10  
12 and also due to the compact design of source 10 which allows  
13 proximity to work site 6.

14 Source 10 has an essentially can-shaped housing 12  
15 including a cylindrical-shaped section 13 and a disc-shaped  
16 section 14. Sections 13 and 14 of housing 12 can be cast,  
17 machined, or otherwise appropriately fashioned from a variety of  
18 suitably workable strong materials, such as urethane, plastic  
19 compounds, etc. Metals can be used for housing 12 so long as  
20 electrical insulation is provided for components contained in  
21 them. The sections can be made as an integral unit or securely  
22 interconnected and sealed together to provide an interior 15 that  
23 is watertight, electrically insulating, and/or otherwise  
24 protected from the ambient.

25 A plurality of batteries 16 is held in interior 15 as a  
26 source of power for an array of light emitting diodes (LED's) 17.

1 Batteries 16 can be high-energy lithium batteries electrically  
2 insulated from ambient water 11 via housing 10, and batteries 16  
3 are separated from LED array 17 by an insulating spacer layer 18.  
4 Insulating spacer layer 18 helps prevent the possibility of  
5 shorting the high-energy batteries as source 10 is subjected to  
6 the routine abuses expected underwater.

7 A disc-shaped, clear acrylic cover 19 to transmit radiation  
8 from LED array 17 extends across cylindrical-shaped section 13 of  
9 housing 12 and is connected to section 13 via an adhesive sealant  
10 19a. Adhesive sealant 19a seals interior 15 from ambient 11.

11 Cover 19 can have a suitable optical coating 19b on either  
12 side to function as a "one-way" mirror so that radiation from LED  
13 array 17 can only travel out of radiation source 10. This may  
14 reduce optical losses that might otherwise be due to the  
15 absorption of reflective waves. Optical coating 19b may also be  
16 a film that permits only one-way travel of radiation from  
17 radiation source 10. Furthermore, optical coating 19b, or the  
18 face of cover 19 can be modified to have light filtering  
19 characteristics. Optionally, many different types of optical  
20 filters might be incorporated in cover 19 and coating 19b and  
21 additional filters may be added on depending on the application.

22 Batteries 16 are located in interior 15 on top of spacer  
23 layer 18 and LED array 17. Batteries 16 can be any of a variety  
24 of off-the-shelf packs of high-power batteries from several  
25 different manufactures to provide enough power over a sufficient  
26 period of time to allow LED array 17 to emit enough radiation

1 through cover 19 to cure a photo-curable or other radiation  
2 curable adhesive. For example, batteries can be six, 3-volt  
3 lithium, size 123 batteries, such as the model CR123A batteries  
4 marketed by Panasonic. The lithium 123 batteries have shown a  
5 ten-year shelf life and have high power density. Optical output  
6 from LED array 17 of source 10 decreases from a peak initial  
7 value as electrical power is drained from batteries 16. This  
8 peak has been measured to be approximately 24mw/cm<sup>2</sup>, and appears  
9 to cause an adhesive to be adequately cured within 15 seconds.

10 LED array 17 can be a suitable number of light emitting  
11 diodes or other high-intensity sources wired in two concentric  
12 sections. Diodes of LED array 17 can be operated together or  
13 focused in many different ways or be arranged in banks of  
14 variable numbers of LED's that can emit sufficient amounts of  
15 470nm (blue) peak. This emission cures photo-curable adhesives  
16 that are responsive to such emission to be cured. Other photo-  
17 curable adhesives responsive to other emissions could have been  
18 used provided the selected LED's emitted sufficient radiation at  
19 the right wavelengths to effect curing of the other adhesives.  
20 Accordingly, many other off-the-shelf LED's having other spectral  
21 emissions may be selected and used to cure other adhesives that  
22 are compatible to be cured by the emissions from the other LED's.  
23 The emissions referred to herein are intended to embrace  
24 electromagnetic radiation from LED's that could be utilized to  
25 energize the photo initiator in the selected radiation-curable  
26 adhesives and may include, but are not limited to include any or

1 all of infrared light, visible light, or ultraviolet light.

2 Although source 10 is designed to cure adhesives, it can be used  
3 in other applications where high intensity LED light is required.

4 Furthermore, in accordance with this inventive concept,  
5 illumination source 10 includes a switch relay 20 in interior 15  
6 that is actuated to connect electrical power from batteries 16 to  
7 LED array 17. Switch relay 20 can have magnetically influenced  
8 reed contact structures (not shown) that are selectably displaced  
9 to close the reed contact structures and establish an electrical  
10 connection between batteries 16 and LED array 17 when a magnetic  
11 switching mechanism 21 is appropriately displaced on housing 12.  
12 In the alternative, the contact structures could be opened to  
13 effect some other interconnection scheme that gets power from  
14 batteries 16 to LED array 17, if desired.

15 Magnetic switching mechanism 21 does not penetrate housing  
16 12 and can be a magnet sized to slideably fit within a groove 13a  
17 between two longitudinal projections 13b on cylindrical-shaped  
18 section 13 of housing 12. Magnetic switching mechanism 21 is  
19 large enough to be engaged by a gloved operator to permit its  
20 longitudinal displacement in groove 13a. Magnetic switching  
21 mechanism 21 is shown at the upper, or "off" position in FIG. 2,  
22 and in this "off" position the magnetically influenced reed  
23 contacts of switch relay 20 are in the open position and do not  
24 connect power from batteries 16 to LED array 17.

25 A safety pin 22, optionally may be retained in a hole 23  
26 provided in the lower end of cylindrical-shaped section 13 to

1 prevent inadvertent displacement of magnetic switching mechanism  
2 21 and actuation of LED array 17. After the operator pulls  
3 safety pin 22 from hole 23 via an interconnected pull-ring 22a,  
4 magnetic switching mechanism 21 is free to be displaced from the  
5 "off" position.

6 The operator moves magnetic switching mechanism 21 to the  
7 lower, or "on" position at the lower end of housing 12 next to  
8 cover 19. The magnetic influence of the magnet of magnetic  
9 switching mechanism 21 closes reed contact structure of switch  
10 relay 20 and establishes an electrical connection between  
11 batteries 16 and LED array 17. Electrical power from batteries  
12 16 is connected to LED array 17, and high-intensity radiation is  
13 emitted from LED array 17 through cover 19 and onto a radiation  
14 (photo)-curable adhesive. Magnetic switching mechanism 21 can  
15 also have a spring 21a connected to housing 12 that biases it to  
16 the "off" position. An operator must overcome the biasing force  
17 to displace magnetic switching mechanism 21 to the "on" position.  
18 If mechanism 21 is released, LED array 17 automatically turns  
19 off. As an alternative, this feature can be changed such that  
20 LED array 17 stays "on" when the switch is released.

21 A fuse 24 can be provided in interior 15 of housing 12 and  
22 be coupled between batteries 16 and LED array 17 to prevent a  
23 hazardous condition that might occur, for example, if an overload  
24 current is created. Such overload current might be caused by an  
25 electrical short that might somehow be created in the circuit  
26 including high-energy lithium batteries 16. If fuse 24 were not



1 included to break the circuit, damage to source 10 and/or injury  
2 to operator might otherwise result from a possible high-energy  
3 surge of current from batteries 16.

4 Housing 12 can have a blade section 25 co-extending from  
5 disc-shaped section 14. Blade section 25 can be made from metal  
6 or other hard material that may be used to scrape-away matter  
7 during preparation of a surface. Housing 12 can also have an  
8 abrasive sandpaper-like or wire brush-like layer 26 on disc-  
9 shaped section 14. An operator can rub layer 26 back and forth  
10 on a surface to be clean it prior to applying an adhesive and  
11 curing it with radiation from source 10. Optionally, layer 26 can  
12 be sponge-like and contain a chemical that "eats away" surface  
13 contaminates when an operator applies it to them.

14 Illumination source 10 can have a compliant rubber boot, or  
15 annular shroud 27 co-extending from cylindrical-shaped section 13  
16 around the periphery of cover 19. Shroud 27 is compliant to  
17 accommodate the surface around an area receiving radiation from  
18 illumination source 10. This will confine the transmission of  
19 high-intensity radiation to the adhesive and prevent the  
20 transmission of any part of the radiation to ambient 11 beyond  
21 work site 6.

22 Illumination source 10 of the invention 10 is a high output  
23 small, portable, and lightweight source that can measure about  
24 four inches in diameter and about two inches high. Its compact  
25 size permits it to be carried by an operator in a pouch or by a  
26 lanyard, and its ergonomic design permits user-friendly tactile

1 operation by a heavily gloved diver. Source 10 may have  
2 different buoyancy characteristics, and for the present intended  
3 underwater application, slight negative buoyancy is preferred.  
4 Source 10 may be of different colors that are easily, or not  
5 easily seen and may have a handle 12a to help placement.

6 In accordance with this invention illumination source 10 is  
7 a cost effective and expendable means to assure bonding by photo-  
8 curable adhesives. In addition illumination system 10 can be  
9 used as a source of illumination where a high-intensity source of  
10 radiation is needed. The size and geometry of housing 12 and  
11 cover 19 of illumination source 10 can be modified as needed and  
12 may be used in conjunction with a number of other like  
13 illumination sources 10 for increased levels of radiation.

14 Different actuation schemes other than switch relay 20 and  
15 switching mechanism 21 may be selected, e. g. acoustic or  
16 electrical actuation schemes. A wide variety of strong corrosion  
17 resistant materials may be chosen for fabrication of the  
18 constituents of housing 12 and compliant shroud 27. Different  
19 sizes and amounts of batteries 16 may be chosen to vary the  
20 magnitudes of single or multiple uses and duration of each use.  
21 The number, color, wiring, and configuration of LED array 17 may  
22 be different in accordance with the task at hand. Gas or  
23 moisture absorbing material may be added to interior 15, and  
24 different internal structural arrangements might be selected.  
25 Optionally, illumination source 10 may include prepackaged photo-

1 curable adhesive adjacent cover 19 and have mounting structure  
2 such as eyes, projections, etc. for attaching things to it.

3 The disclosed components and their arrangements as  
4 disclosed herein, all contribute to the novel features of this  
5 invention. These novel features of illumination source 10 assure  
6 more reliable and effective initiation and curing of photo-  
7 curable adhesives and bonding of objects together. Therefore,  
8 within the scope of this inventive concept illumination source 10  
9 may be differently shaped and can be tailored to accommodate  
10 differently shaped surfaces for different tasks. Consequently,  
11 having this disclosure in mind, one skilled in the art to which  
12 this invention pertains will select and assemble components for  
13 illumination source 10 from among a wide variety available in the  
14 art. Therefore, the disclosed arrangement is not to be construed  
15 as limiting, but rather, is intended to be demonstrative of this  
16 inventive concept.

17 It should be readily understood that many modifications and  
18 variations of the present invention are possible within the  
19 purview of the claimed invention. It is to be understood that  
20 within the scope of the appended claims the invention may be  
21 practiced otherwise than as specifically described.